

* NOTICES *

Kono et al.

JPO and INPIT are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a nonaqueous electrolyte rechargeable battery and its electrode.

[0002]

[Description of the Prior Art] In recent years, high performance-ization to the rechargeable battery which is the power source of these electronic equipment is demanded with the miniaturization of electronic equipment, such as a cellular phone and a portable personal computer, and buildup of need. The nonaqueous electrolyte cell which used for the negative-electrode ingredient occlusion and the matter which can be emitted for a lithium like a carbon material as this rechargeable battery is developed, and it has spread as a power source for pocket electronic equipment. This nonaqueous electrolyte rechargeable battery has the description of unlike the conventional cell it being lightweight and having 4V class high electromotive force, and that outstanding engine performance attracts attention.

[0003] Then, applying said nonaqueous electrolyte rechargeable battery as a power source of an electric vehicle, a power tool, a cordless cleaner, etc., etc. is examined. For such an application, it is required compared with the conventional nonaqueous electrolyte rechargeable battery that a high energy consistency should be formed more.

[0004] The nonaqueous electrolyte rechargeable battery which used the lithium metal, the lithium alloy, etc. for the active material of an electrode is expected as a high energy cell, and researches and developments are furthered briskly.

[0005] As positive active material, although LiCoO_2 , LiMn_2O_4 , etc. are put in practical use, the lithium ion battery using occlusion and the carbon material to emit as a negative-electrode active material is widely put in practical use in the lithium, and the rechargeable battery which used the lithium metal and the lithium alloy for the negative electrode is not yet put in practical use.

[0006] The reason the lithium metal is not put in practical use has the trouble that an internal short circuit and a cycle life are short, in order that desorption by degradation of the lithium by the reaction of nonaqueous electrolyte and a lithium alloy and generating of the lithium of the shape of a dendrite by the repeat of charge and discharge (arborescence) may occur. In order to solve such a trouble, the research which alloys a lithium and is used for a negative-electrode active material was made. For example, although there is a technique which uses a lithium-aluminum alloy etc. as a negative electrode (for example, J.O.BesenHard, J.Electroanal.Chem., 94, 77. (1978)), under charge and discharge with shallow fixed quantity of electricity, effectiveness is improvable so that a part of aluminum may be used. However, if deep charge and discharge are repeated, by the volume change of an electrode, a negative-electrode active material will carry out pulverization, and some negative-electrode active materials will be too desorbed from a negative electrode. Consequently, in order that the amount of negative-electrode active materials in a negative electrode might decrease gradually, the problem was in the charge-and-discharge cycle property.

[0007] Moreover, although the copper-tin alloy, the alloys, for example, the tin-nickel alloy, other than a lithium alloy, etc. is studied as a negative-electrode active material for attaining a high energy cell, since the same reason problem as a lithium alloy arises, it has not resulted in utilization.

[0008]

[Problem(s) to be Solved by the Invention] As mentioned above, there was a problem that the cycle property of what can raise an energy density if a metallic material is used as a negative-electrode active material fell in the conventional nonaqueous electrolyte rechargeable battery.

[0009] In view of such a problem, it succeeds in this invention, and an energy density is high and it aims at offering the nonaqueous electrolyte rechargeable battery excellent in the charge-and-discharge cycle engine performance.

[0010]

[Means for Solving the Problem] The nonaqueous electrolyte rechargeable battery of this invention is formed in the positive electrode which possesses positive active material at least, a charge collector, and this current collection body surface, and is characterized by having nonaqueous electrolyte inserted into the negative electrode possessing the enveloping layer which consists alkali metal of a carbon material formed on the negative-electrode active material layer which has occlusion and the alloy to emit, and this negative-electrode active material layer, and said positive electrode and negative electrode.

[0011] Since it is held by the enveloping layer in an electrode even if a negative-electrode active material atomizes it, as a result of controlling atomization of an alloy by forming an enveloping layer in a negative-electrode active material layer front face and carrying out by repeating the charge and discharge of a cell although the negative-electrode active material layer which consists of an alloy is used for the nonaqueous electrolyte rechargeable battery of this invention, it becomes possible [controlling reduction of a negative-electrode active material].

[0012] Moreover, about alkali metal, since the carbon material which can pass alkali metal, such as a lithium, as an enveloping layer is used, a negative-electrode active material does not become hindrance, in case it emits, occlusion and. Moreover, since it has the occlusion and bleedoff ability of the carbon material [itself] alkali metal, compared with the case where it covers with other ingredients, lowering of the energy density by the enveloping layer can be suppressed.

[0013] Moreover, as for the thickness of said active material layer, it is desirable that it is [0.01 micrometer or more] 50 micrometers or less.

[0014] Moreover, as for the from film of said enveloping layer, it is desirable that it is [0.1 micrometer or more] 200 micrometers or less.

[0015] Moreover, as for the film parameter of a negative-electrode active material layer to the thickness of said enveloping layer, it is desirable that it is [or more 0.01] 0.95 or less.

[0016] Although the ratio of a negative-electrode active material layer can be improved and the occlusion and bleedoff ability of the alkali metal of a negative-electrode active material can be raised by reducing the ratio of an enveloping layer, when the thickness of an enveloping layer is too small, there is a possibility that it may become impossible to hold a negative-electrode active material. Moreover, when the thickness of an enveloping layer is large, there is a possibility of making low the permeability to the negative-electrode active material of alkali metal.

[0017]

[Embodiment of the Invention] Drawing 1 is a top view about the left half plane of a cylindrical nonaqueous electrolyte rechargeable battery, shows a right half plane with drawing of longitudinal section, and explains it with reference to a drawing below.

[0018] As for the container 1 of the shape of a closed-end cylinder which consists of metal, for example, stainless steel, the insulator 12 is arranged at the pars basilaris ossis occipitalis. This electrode group 3 is contained in said container 1. Said electrode group 3 has structure which whirled so that said negative electrode 6 might be located outside, and wound upwards the band-like object which carried out the laminating of a positive electrode 4, a separator 5, a negative electrode 6, and another separator 5 in this sequence. Said separator 5 is formed from a nonwoven fabric, polypropylene microporous film, polyethylene microporous film, and a polyethylene-polypropylene fine porosity laminated film. Moreover, the electrolytic solution permeates into a separator 5 because the electrolytic solution holds in said container 1.

[0019] Caulking immobilization of the positive-electrode terminal 9 of the hat configuration arranged at the relief valve 8 arranged on the PTC component 7 by which opening of the hole was carried out to the center section, and said PTC component 7, and said relief valve 8 is carried out through the insulating gasket 10 at up opening of said container 1. The end of the current collection lead 11 for positive electrodes is connected to said positive electrode 4, and the other end is connected to said positive-electrode terminal 9, respectively. Said negative electrode 6 is connected to said container 1 which is a negative-electrode terminal through the current collection lead 13 for negative electrodes.

[0020] In addition, in the nonaqueous electrolyte rechargeable battery concerning this invention, you may be the electrode group which has the structure where the laminated material with which a sheathing material consists of a laminate film, and consists of said positive electrode and a negative electrode, and a separator in said sheathing material was wound in the shape of flat, and the structure where nonaqueous electrolyte was contained.

[0021] Next, said positive electrode 4, said separator 5, said negative electrode 6, and said nonaqueous electrolyte are explained in detail.

[0022] 1) Positive-electrode 4 positive electrode contains positive active material at least, and usually forms and uses a positive-active-material layer for sheet-like one side or both sides of a charge collector. For example, what is necessary is to apply, dry and press the suspended solid which suspended suitably positive active material, the electric conduction

agent, and the binder in the solvent in current collection body surfaces, such as aluminium foil, and just to form a positive-active-material layer in them.

[0023] Positive active material carries out occlusion of the alkali metal at the time of discharge of a cell, and it can be used for it, without being limited especially if alkali metal can be emitted at the time of charge.

[0024] For example, various oxides and a sulfide are mentioned as positive active material used for the rechargeable lithium-ion battery using the lithium as an alkali metal. for example, a manganese dioxide (MnO_2), a lithium manganese multiple oxide (for example, LiMn_2O_4 or LiMnO_2), lithium nickel complex oxide (for example, LiNiO_2), a lithium cobalt multiple oxide (LiCoO_2), a lithium nickel cobalt multiple oxide (for example, $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$), a lithium manganese cobalt multiple oxide (for example, $\text{LiMn}_x\text{Co}_{1-x}\text{O}_2$), and a vanadium pentoxide (for example, V_2O_5) etc. -- it is mentioned. Moreover, organic materials, such as a conductive polymer ingredient and a disulfide system polymer ingredient, are also mentioned. As for more desirable positive active material, a lithium manganese multiple oxide (LiMn_2O_4) with high cell voltage, lithium nickel complex oxide (LiNiO_2), a lithium cobalt multiple oxide (LiCoO_2), a lithium nickel cobalt multiple oxide ($\text{LiNi}_{0.8}\text{Co}_{0.2}\text{O}_2$), a lithium manganese cobalt multiple oxide ($\text{LiMn}_x\text{Co}_{1-x}\text{O}_2$), etc. are mentioned.

[0025] Although it can be used without being restricted as a charge collector especially if it is a conductive ingredient, it is desirable to use the ingredient which cannot oxidize especially easily as a charge collector for positive electrodes at the time of a cell reaction, for example, it should just use aluminum, stainless steel, titanium, etc.

[0026] As said electric conduction agent, acetylene black, carbon black, a graphite, etc. can be mentioned, for example. As said binder, polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVdF), fluorine system rubber, etc. are mentioned, for example. the compounding ratio of said positive active material, an electric conduction agent, and a binder -- 80 - 95 % of the weight of positive active material, and an electric conduction agent -- it is desirable to make it the range of 2 - 7 % of the weight of binders three to 20% of the weight.

[0027] 2) The sectional view showing an example of the negative electrode applied to this invention at negative-electrode 6 drawing 2 is shown.

[0028] The negative electrode 6 concerning this invention has the charge collector 21, the negative-electrode active material layer 22 which is formed in a current collection body surface and contains a negative-electrode active material at least, and the enveloping layer 23 which consists of a carbon material formed on this negative-electrode active material layer.

[0029] Although a charge collector 21 can be especially used without a limit if it is a conductive ingredient, it is desirable to use the ingredient which is especially hard to dissolve as a charge collector for negative electrodes at the time of a cell reaction, for example, sheet-like copper, nickel, etc. should just be used for it.

[0030] The negative-electrode active material layer 22 carries out the stratification of the mixture containing a negative-electrode active material independent or a negative-electrode active material. As this negative-electrode active material, alkali metal is emitted at the time of discharge of a cell, it is the metallic material which can carry out occlusion of the alkali metal at the time of charge, for example, lithium alloys, such as a Sn-nickel alloy, a Sn-nickel-Cu alloy, a Sn-Sb alloy, a Cu-Sn alloy, a Sn-Sb-Cu Al alloy, a Mg-Sn alloy, a Mg-Sb alloy, a Mg-Sb-nickel alloy, and a Li-aluminum alloy, a Li-Pb alloy, a Li-In alloy, a lithium metal, etc. can be mentioned in the rechargeable lithium-ion battery using the lithium as an alkali metal, for example. Especially the alloy containing a lithium can raise charge-and-discharge effectiveness remarkably. It is desirable less than [more than 0.02wt%55wt%] and that the desirable range uses especially less than [0 and more than 05wt%45wt%] and the alloy which contains the lithium not more than more than 0.1wt%30wt% still more desirably preferably.

[0031] Moreover, especially the crystal structure of the negative-electrode active material layer formed by doing in this way may be a crystal phase, a microcrystal, or an amorphous phase, without being limited. Furthermore, what is necessary is to form a single phase by the ingredient system, to consider as the alloy which consists of two or more phases, or just to adjust if needed, when a negative-electrode active material is an alloy. Moreover, although various impurities, such as fluorine, may mix into a negative-electrode active material, if each amount of impurities is less than [1wt%], the function as a negative-electrode active material can usually fully be demonstrated.

[0032] As for the thickness of the negative-electrode active material layer 22, it is desirable that they are 0.01-50 micrometers and 0.05 more micrometers - 30 micrometers, and it is desirable to make it especially 0.1 micrometers - 15 micrometers. Since the amount of lithium ion occlusion of a negative electrode will become small if smaller than the range which thickness mentioned above, cell capacity will become small. Moreover, if larger than the range mentioned above, a negative-electrode active material atomizes, and there is a possibility that it may be desorbed from a negative-electrode active material layer.

[0033] The negative-electrode active material layer 22 can be formed in a current collection body surface using a

known approach, for example, a sintering process, a super-quenching method, the galvanizing method, a spatter, the rolling-out method, a sol-gel method, vacuum deposition, etc.

[0034] For example, the quenching object of the shape of a layer which becomes a current collection body surface from a negative-electrode active material can be created by quenching with the super-quenching equipment which used the single rolling method or the congruence rolling method, moving the alloy which consists of a negative-electrode active material adjusted to the predetermined presentation ratio arranged on a charge collector in the range of passing speed 5 - 50 m/s. Moreover, a negative-electrode active material layer can be formed in a current collection body surface by carrying out pressing of the powder of each element which constitutes a negative-electrode active material to a charge collector and one, and heat-treating it under an inert gas ambient atmosphere or a vacuum after that.

[0035] Moreover, you may heat-treat further if needed to the negative-electrode active material layer 22 formed by these approaches. Although this processing temperature is influenced with the constituent of the negative-electrode active material layer 22, it is desirable to carry out in an about 100 degrees C - about 500 degrees C temperature requirement. Moreover, although the optimal heat treatment time amount is changed with heat treatment temperature, 1 - 50 hours is more preferably good for 0.1 to 500 hours preferably as a rule of thumb for 0.5 to 100 hours.

[0036] An enveloping layer 23 is formed on a negative-electrode active material layer, and also when it atomizes, it functions as covering for holding this particle on a charge collector, while controlling the volume change of a negative-electrode active material layer and controlling atomization. By forming this enveloping layer, it becomes possible to control the cubical expansion of a negative-electrode active material layer, and fine complications-ization can be prevented.

[0037] It forms of components, such as a carbon material conventionally used as a negative-electrode active material as an enveloping layer 23, or this carbon material, binding resin. As a carbon material, graphite, acetylene black, carbon black, etc. are specifically mentioned.

[0038] Since passage of a lithium ion is possible for this enveloping layer 23, it does not bar the occlusion and bleedoff of the lithium element to the positive-active-material layer 22 by the enveloping layer 23. Moreover, since it also has a function as a negative-electrode active material as mentioned above, compared with the case where other ingredients are used, the amount of lithium occlusion of a negative electrode can be raised. If an electric conduction agent is furthermore added in an enveloping layer 23, it will become possible to raise the current collection effectiveness in the inside of the coat film.

[0039] As for the thickness of an enveloping layer 23, it is desirable to be referred to as 0.1 micrometers or more 200 micrometers or less. If it is difficult to form the uniform film if thinner than 0.1 micrometers and it exceeds 200 micrometers, the permeability of a lithium ion will fall. Moreover, as for the film parameter of the negative-electrode active material layer 22 to the thickness of an enveloping layer 23, it is desirable to carry out to 0.95 or less [0.01 or more]. It becomes difficult to fully control desorption by the negative-electrode active material layer, if smaller than 0.01, if 0.95 is exceeded, the ratio of a negative-electrode active material will decrease, and there is a possibility that the amount of occlusion of a lithium may fall.

[0040] For example, an enveloping layer 23 is created as follows.

[0041] Although the enveloping layer 23 should just contain the negative-electrode active material at least, it consists of an electric conduction agent a carbon material, a binder, and if needed, and is formed by carrying out spreading / desiccation press of the suspension which suspended these components in the suitable solvent through a negative-electrode active material layer on a charge collector 21.

[0042] As said binder, polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVdF), fluorine system rubber, ethylene-butadiene rubber (SBR), a carboxymethyl cellulose (CMC), etc. are mentioned, for example.

[0043] Moreover, about the solvent used in case an enveloping layer 22 is formed, when the negative-electrode active material layer 22 reacts easily with water, it is desirable to use a suitable organic solvent, for example, N-methyl pyrrolidone (NMP) solution. the compounding ratio of said negative-electrode active material, an electric conduction agent, and a binder -- 70 - 95 % of the weight of negative-electrode active materials, and an electric conduction agent -- it is desirable to make it the range of 2 - 10 % of the weight of binders zero to 25% of the weight.

[0044] In addition, a negative-electrode active material layer and an enveloping layer can be formed in sheet-like one side or both sides of a charge collector.

[0045] 3) The separator 5 aforementioned separator 5 is for insulating between a positive electrode and a negative electrode, it can consist of an insulating ingredient, can be used, without being limited especially if it has the pore which connects between a positive electrode and a negative electrode, and can specifically mention the nonwoven fabric made of synthetic resin, a polyethylene porosity film, a polypropylene porosity film, etc. while it holds the nonaqueous electrolyte concerning this invention.

[0046] 4) The liquid electrolyte prepared when the nonaqueous electrolyte held at the nonaqueous electrolyte separator 5 dissolves an electrolyte in a non-aqueous solvent or the polymer gel-like electrolyte which contained said non-aqueous solvent and said electrolyte in polymeric materials, the giant-molecule solid electrolyte only containing said electrolyte, and the inorganic solid electrolyte which has lithium ion conductivity are mentioned.

[0047] As a liquid electrolyte, it is what dissolved lithium salt, for example in the non-aqueous solvent of a lithium cell as an electrolyte, a well-known non-aqueous solvent can be used, and it is more desirable than annular carbonate, such as ethylene carbonate (EC) and propylene carbonate (PC), and annular carbonate and annular carbonate to use the non-aqueous solvent which makes a subject a mixed solvent with the non-aqueous solvent (the following 2nd solvent) of hypoviscosity.

[0048] As the 2nd solvent, dimethoxyethane, diethoxy ethane, etc. are mentioned as the chain-like ether, such as a tetrahydrofuran and 2-methyl tetrahydrofuran, for example as chain-like carbonate, such as dimethyl carbonate, methylethyl carbonate, and diethyl carbonate, gamma-butyrolactone, an acetonitrile, methyl propionate, ethyl propionate, and cyclic ether.

[0049] As an electrolyte, although alkali salt is mentioned, especially lithium salt is mentioned. As lithium salt, a 6 fluoride [phosphoric-acid] lithium (LiPF_6), hoe lithium fluoride (LiBF_4), a 6 arsenic-fluoride lithium (LiAsF_6), lithium perchlorate (LiClO_4), a trifluoro meta-sulfonic-acid lithium (LiCF_3SO_3), etc. are mentioned. Especially, a 6 fluoride [phosphoric-acid] lithium (LiPF_6) and hoe lithium fluoride (LiBF_4) are desirable. As for the amount of dissolutions to said non-aqueous solvent of said electrolyte, it is desirable to carry out in 0.5-2.0 mols/l.

[0050] It is what dissolved said solvent and said electrolyte in polymeric materials as a macromolecule gel electrolyte, and was made into gel, and the polymer of monomers, such as a polyacrylonitrile, polyacrylate, polyvinylidene fluoride (PVdF), and polyethylene oxide (PECO), or a copolymer with other monomers is mentioned as polymeric materials.

[0051] As a solid electrolyte, it dissolves in polymeric materials and said electrolyte is solidified. As polymeric materials, the polymer of monomers, such as a polyacrylonitrile, polyvinylidene fluoride (PVdF), and polyethylene oxide (PEO), or a copolymer with other monomers is mentioned. Moreover, the ceramic ingredient containing a lithium is mentioned as an inorganic solid electrolyte, and Li_3N , Li_3PO_4 - Li_2S - SiS_2 , and LiI - Li_2S - SiS_2 glass etc. is mentioned especially.

[0052] In addition, in drawing 1 mentioned above, although the example applied to the cylindrical shape nonaqueous electrolyte rechargeable battery was explained, it is applicable also like a square shape nonaqueous electrolyte rechargeable battery. Moreover, the electrode group contained by the container of said cell may make not only a spiral type but a positive electrode, a separator, and a negative electrode the gestalt which carried out two or more laminatings in this sequence.

[0053] In addition, if the nonaqueous electrolyte rechargeable battery concerning this invention is in the range of this invention, it will not be limited to the gestalt mentioned above.

[0054]

[Example] The nonaqueous electrolyte rechargeable battery as shown in drawing 1 was created.

[0055] <production of a positive electrode> -- first, N-methyl pyrrolidone (NMP) solution was added with 2.5 % of the weight of acetylene black, 3 % of the weight of graphite, and 4 % of the weight (PVdF) of polyvinylidene fluorides, 91 % of the weight of lithium cobalt oxide (LiCoO_2) powder of positive active material was mixed, it applied to the charge collector of aluminium foil with a thickness of 15 micrometers, and the positive electrode of electrode consistency 3.0 g/cm³ was produced by pressing after desiccation.

[0056] <production of a negative electrode> -- first, on the charge collector which consists of copper foil with a thickness of 12 micrometers, plating of the alloy thin film which consists of presentation 0.75Sn-0.25nickel was performed as follows, and the negative-electrode active material layer which consists of a Sn-nickel alloy was formed.

[0057] The electrocrystallization conditions at the time of plating prepared the pyrophosphoric-acid bath of tin chloride 45 g/L, nickel chloride 10 g/L, potassium-pyrophosphate 200 g/L, glycine 20 g/L, and aqueous ammonia 5 ml/L, and made PH 8 and 50 degrees C of bath temperature. The negative-electrode active material layer made from an alloy thin film of 1 micrometer of thickness was produced by current density 0.5 A/dm² on the above-mentioned conditions.

[0058] Next, the enveloping layer was formed in the negative-electrode active material layer front face.

[0059] First, 5 % of the weight of graphite, 3 % of the weight of acetylene black, and 7 % of the weight of PVdF(s) and a NMP solution were added to 85 % of the weight (MCF) of mesophase pitch based carbon fibers, and it mixed, and applied to the negative-electrode active material layer front face obtained previously by the thickness of 50 micrometers, and after desiccation, by pressing, the enveloping layer was formed and the negative electrode was produced.

[0060] The separator which consists of a porosity film made from <production of electrode group> polyethylene was

prepared, after carrying out the laminating of the positive electrode obtained previously and the negative electrode through this separator, it wound around the curled form and the electrode group was produced so that said negative electrode might be located in the outermost periphery.

[0061] The 6 fluoride [phosphoric-acid] lithium (LiPF₆) was made the <adjustment of nonaqueous electrolyte> pan 1.0 mols / L dissolution to (the rate 1:2 of a mixed volume ratio) at the mixed solvent of ethylene carbonate (EC) and methylethyl carbonate (MEC), and nonaqueous electrolyte was adjusted to it.

[0062] The cylindrical shape nonaqueous electrolyte rechargeable battery shown in drawing 1 which contained the obtained electrode group and said electrolytic solution, respectively, and mentioned them above in the closed-end cylindrical cup made from stainless steel was assembled.

[0063] For the example of comparison 1 comparison, as a negative electrode, an alloy was not used for a negative-electrode active material, but the nonaqueous electrolyte rechargeable battery was assembled like the example 1 except for having used the powder of a mesophase pitch based carbon fiber (specific-surface-area 2.5m²/g [according / mean fiber length / to 0.35nm and a BET adsorption method] according [the diameter of fiber] in 25 micrometers and the average spacing d (002) to 7 micrometers) heat-treated at 2900 degrees C.

[0064] As example of comparison 2 negative electrode, the nonaqueous electrolyte rechargeable battery was created like the example 1 except for having not formed an enveloping layer.

[0065] Except for having replaced the alloy used for an example 2 - 10 negative-electrode active material layer with the alloy shown in a table 1, the nonaqueous electrolyte rechargeable battery was created like the example 1.

[0066] Each nonaqueous electrolyte rechargeable battery obtained in the <cell assessment> examples 1-10 and the examples 1 and 2 of a comparison was evaluated as follows.

[0067] After charging each nonaqueous electrolyte rechargeable battery to 4.2V by charging current 1A for 2.5 hours, the charge-and-discharge cycle trial which discharges by 5A to 2.0V was performed. From the result, the high-rate-discharge capacity factor and the capacity maintenance factor (ratio of the discharge capacity of a 300 cycle eye to the discharge capacity of 1 cycle eye) were measured about each nonaqueous electrolyte rechargeable battery. The result is written together to the following table 1. In addition, a high-rate-discharge capacity factor is a ratio at the time of setting high-rate-discharge capacity of the carbonaceous ingredient negative electrode of the example 1 of a comparison to 1.

[A table 1]

	負極活物質	被覆層	高率放電 容量	容量 維持率	負極活物質 層厚
実施例 1	0.75Sn-0.25Ni	C	2.1	93%	0.1 μm
実施例 2	0.8Sn-0.1Ni-0.1Cu	0.6C-0.4Hg	2.5	95%	0.3 μm
実施例 3	0.75Sn-0.3Sb	0.85C-0.05Si	1.7	91%	30 μm
実施例 4	0.6Cu-0.5Sn	0.7C-0.3Al	1.9	96%	1.0 μm
実施例 5	0.3Sn-0.3Sb- 0.2Cu-0.2Al	0.5C-0.4Si-0.1Hg	2.8	90%	0.05 μm
比較例 1	C	—	1.0	95%	20 μm
比較例 2	0.75Sn-0.25Ni	—	1.9	5%	10 μm

It turns out that high-rate-discharge capacity and the capacity maintenance factor of the nonaqueous electrolyte rechargeable battery of the examples 1-10 of this invention at the time of 300 cycles improve by leaps and bounds compared with nonaqueous charge ***** of the example 2 of a comparison, and it excels in a cycle property so that clearly from a table 1.

[0068]

[Effect of the Invention] As explained in full detail above, according to this invention, a nonaqueous electrolyte rechargeable battery with a good cycle property can be offered by high-rate-discharge capacity.

[Translation done.]